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EVALUATING PLANT GROWTH IN ORGANIC SEEDLING POTS

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ABSTRACT: Organic containers are environmentally-friendly and are considered a natural approach to starting vegetable seeds. There are several different types of organic seed starting pots to use when vegetables are grown from seeds. Usually the seeds are sown directly into a potting mix inside the pot, so they grow until it's time to be placed in the greenhouse or in the garden. At planting time, there is no need to remove the seedling from its container. Vegetable seedlings move straight to the garden, rather than being repotted. In addition, organic pots can improve the soil. After the seedling is planted the pot's organic material breaks down in the soil during the planting season. Sustainability is a buzzword these days, and sustainable technologies and methods are encouraged to be used. Suriname produces a lot of waste from husk from rice and also from newspapers, which are daily produced. Therefore in lieu of protecting the environment against pollution and to promote sustainable agricultural methods, a study was conducted to produce organic containers from newspapers, rice husk, and manure, and to evaluate the growth of selected vegetable seedlings in these organic containers. Preliminary results indicated that the pots did not restrict root growth, dissolved in the soil quickly, and allowed roots to proliferate in the rhizo-sphere. The economics and efficiency issues of the production of organic containers were also addressed.

Keywords: Organic seedling pots, tomato, lettuce, cauliflower, kalian.

Introduction

One of the most important elements for plant development is nitrogen in the soil. In organic farming, certain types of grasses or legumes, or cow manure are used to fix nitrogen back into the soil. Nitrogen applied in the form of manure fosters favorable soil microbes, which are indicative of healthy and fertile soil. Cow pots for seedling plants also have these properties. These type of pots are the creation of the brothers Matt and Ben Freund, second-generation dairy farmers in the northwest hills of Connecticut (Warren, 2013). Cow pots are an ecological way to grow strong, healthy plants. These innovative seed starting pots are made from cow manure that are mostly composted. The benefits of cow manure pots include: composed of a naturally reoccurring resource; the manufacturing process removes all weeds pathogens and odors; cow manure retains water well; pots retain shape and strength in a greenhouse setting; roots penetrate the walls and bottom of the pot; cow pots are directly planted into the soil; easy and efficient handling without harm to root structure and once planted cow pots decompose within a matter of weeks (Warren, 2013).

McDonald (2013) stated that plastic seedling pots must be cleaned after every period they have been used. This process takes too much time and does not guarantee that plastic pots are pathogen free. When biodegradable pots like: cow-, newspaper- or fiber pots are used for seedlings, these pots have a lot of benefits for the plant, the environment and the user. Newspaper pots are made of newspaper mache. While

almost every other kind of pot costs money, the creation of seedling pots from old newspapers is at no cost. Even if there is not a stack of old newspapers in people's houses, it doesn't take long to acquire donations from neighbors and friends who would prefer to see their used newspaper recycled to a new and useful product. The pots will help the compost to remain moist, since it won't dry out when being watered and it will biodegraded when transplanted into the garden. Neither the newspaper nor the ink actually add nutritional value to the soil when these cups are planted into the soil as the seedlings are planted. The ink contains carbon, which is good for the plants, and the paper is beneficial in maintaining the moisture content of the soil. According to Karen Hager (2011), biodegradable pots like cow manure pots or newspaper pots have several advantages over plastic pots for starting seeds. First, they are easier to use, because it is not necessary to repot the plant. When it comes time to transfer the plants into the garden, simply pop the plant, with biodegradable pot and all, into the planting hole. No repotting the plant means that you won't disturb the roots from the plant you are transplanting. The process of transplanting moving from a small pot to a larger one or directly into your garden can damage and remove the delicate hairs on the plant's roots. This prevents the roots from absorbing water from the soil or compost properly, and can halt plant growth for up to three weeks.

The overall purpose of the study was to evaluate the growth of selected vegetables in organic seed pots. Specifically, the objectives included evaluation of:

1. Growth of *Lactuca sativa* (lettuce), *Lycopersicon esculentum* Mill. (tomato), *Brassica oleracea* L. var. *boltrytis* (cauliflower) and *Brassica oleracea* L. var. *albogabra* (kalian) in cow pots and news- papermache pots.
2. Growth of *Brassica oleracea* L. var. *albogabra* (kalian) seedlings in organic pots in the soil.

Material and Methods

Pot Production

Two types of pots were made manually. The information about used materials and material ratio for each pot are shown in Table 1. First a mixture was made from the material combination of each pot, then the seedling pots were shaped with a drainage hole and then the pots were placed in a ventilated area to air dry.

Table 1. Material used to make organic pots

Pot type	Material and material ratio
A	70% paper mache + 30% cow manure
B	80% cow manure + 20% rice husk
C	Plastic pot (PET)

Seed Germination Capacity Test

Seed germination of each type of seed was conducted for a period of 48 hours. Seed type, number of seeds and germination percentage of seeds used for this experiment are shown in Table 2.

Table 2. Seed germination of types of four vegetables

Seed type	Number of seeds	Germination (%)
Lettuce	20	99
Tomato	20	65
Cauliflower	20	95
Kalian	20	55

Field study: The field studies were conducted in the beginning of May till June 2013 in the greenhouse of the Department of Agriculture at the Anton de Kom University in Suriname. The field study was divided in two sub- experiments. First, sub- experiment one was conducted, followed by sub- experiment two. For sub- experiment 1 the growth of the seedlings plants in the three type of pots was evaluated. The experimental design was executed as a randomized complete block with four replications. A homogeneous plant medium (70% pot soil + 30% river sand) was used. All seeds (lettuce, tomato, cauliflower, kalian) were germinated first and then planted in the seedlings pots.

The experimental design of experiment 2 was also a randomized complete block with four replications. Only kalian seedling plants (3 weeks old) were used in the second experiment. In this experiment the growth of seedling plants was evaluated in soil (soil combined with manure, shells and humus). The N, P and K requirement in soil and for the plant growth of l kailan are listed in Table 3. The kalian plants were harvested 3 weeks after planting in the soil. The age of these plants from seed to harvesting was 7 weeks. Plants in pot A and pot B were planted together in the soil and the plants in pot C were planted without a pot.

Table 3. N, P and K in the soil and N, P and K requirements for kalian.

	N (%)	P (%)	K (%)
Soil (50% shells, 25% riversand, 25% cowmanure)	0.21	0.31	0.38
Requirements for the growth of *Brassica sp.*	1	0.5	1
Fertilizer application (organic manure before planting)	0.64	0.64	0.65

De Ruiter, Chakwizira, and Maley (2010)

Measurements: In experiment 1, the number of leaves in time of each plant, shoot length, root length (only for tomato and cauliflower) and plant weight (only for tomato and cauliflower) were measured. In the second experiment shoot length, number of leaves, plant (shoot) weight and leaf area were measured.

Data Analysis: All data were subjected to analysis of variance (ANOVA) using the Sigmastat statistical program. Differences in means of different treatments were evaluated for significance following LSD Fisher. Significance was set at $P<0.05$.

Results

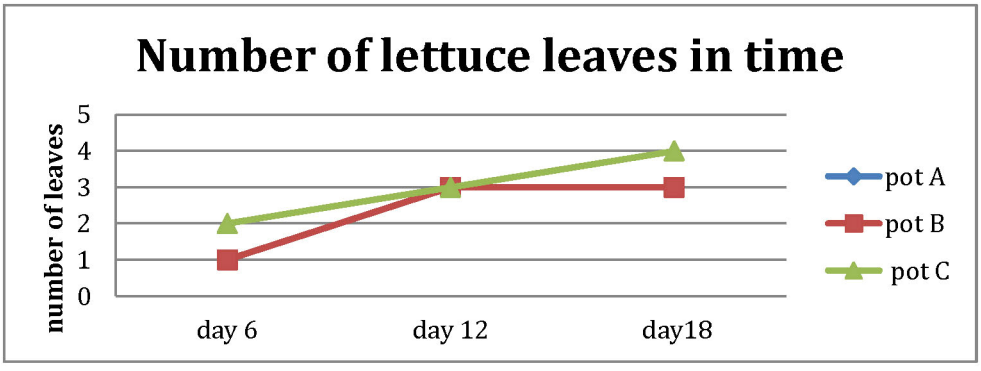
Results of Experiment 1

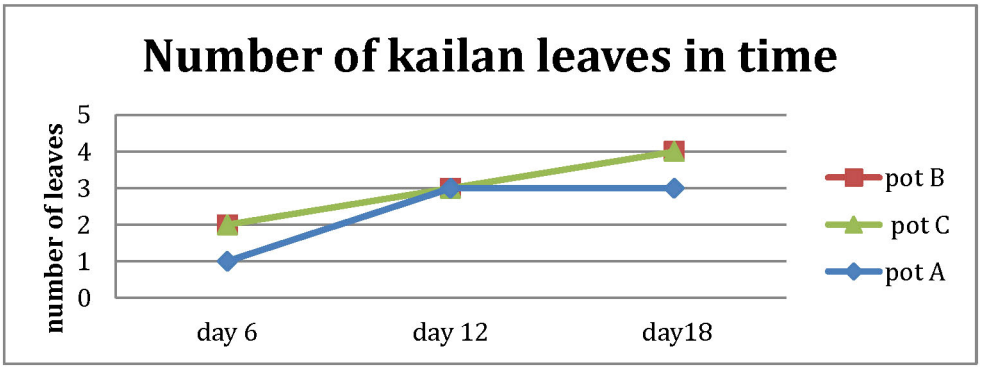
As the number of leaves of the several type plants were compared to the control pots (pot C), there was a significant difference ($p= 0.004$) in the number of leaves over time for lettuce, kalian ($p= 0.009$) and cauliflower ($p= 0.009$) grown in the various pots (Figure 1). The tomato seedling results showed that there was no significant difference ($p= 0.250$) in

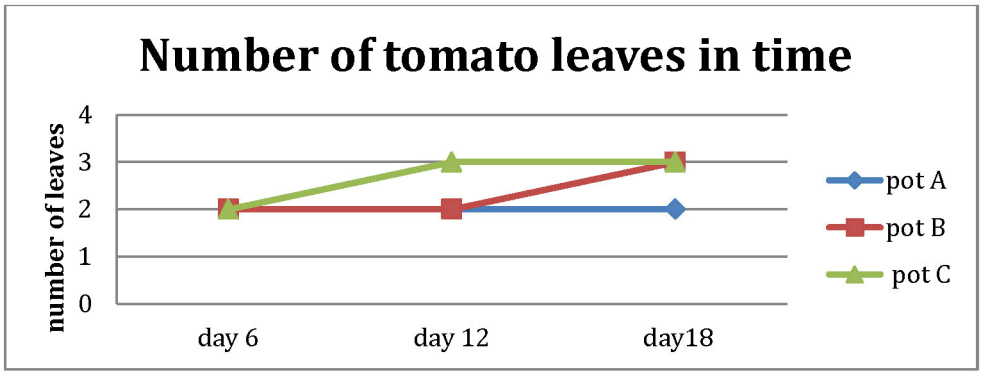
the number of tomato leaves in time among the pot treatments A, B and the control pot (Table 4). There was no significant difference ($p > 0.05$) in the plant heights of the lettuce and kalian between the organic pots and control pots. There was, however, a significant difference in plant height between the tomato seedling and cauliflower plants in each pot (Table 4). For root length of the tomato ($p = 0.005$) and the cauliflower (0.026) seedlings, there was a significant difference between the pots. The plants grown in the plastic pots had the biggest root length. Between the root length of the tomato and cauliflower plants there were no significant differences. The plant weight of the tomato and cauliflower seedlings grown in the various pots were significantly different from each other ($p < 0.005$). Seedling plants (tomato and cauliflower) grown in the control pots had a higher plant weight than the plants grown in the organic pots (Figure 2). The weight of the seedling plants in pot B was higher than that of the plants grown in pot A

Results of Experiment 2

There was no significant difference ($p = 0.47$) between the total number of leaves of kailan planted with the organic pots in soil compared to the control plants (Table 5). There were significant differences ($P = 0.007$) in plant height of these plants among the various types of pots. The control plants were the tallest compared to the plants grown in the organic pots. There were no significant differences in plant weight of the kalian plants between the pots ($P = 0.007$) and the blocks ($P = 0.078$). However, there was a significant difference in leaf area between the kalian planted in the pots and the control (Table 5). The control kalian plant had the biggest leaf area (Figure 3).







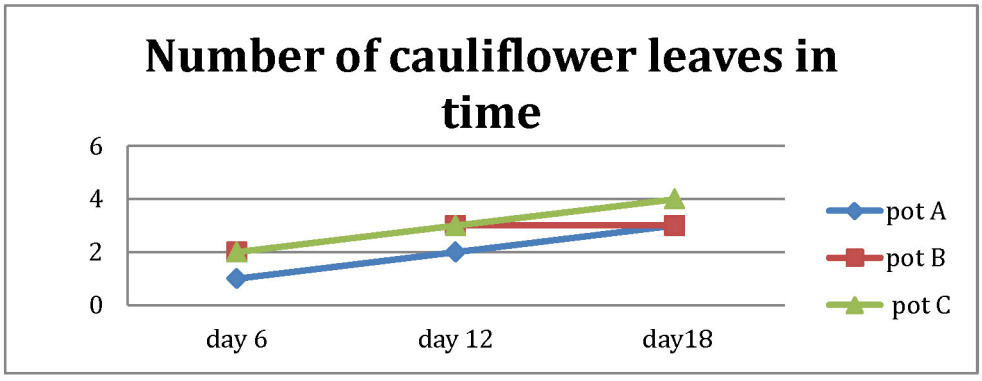


Figure 1. Graphs showing the relation between number of leaves in time (6 days, 12 days and 18 days after planting) of lettuce, kailan, tomato and cauliflower grown in various types of pots (experiment 1).

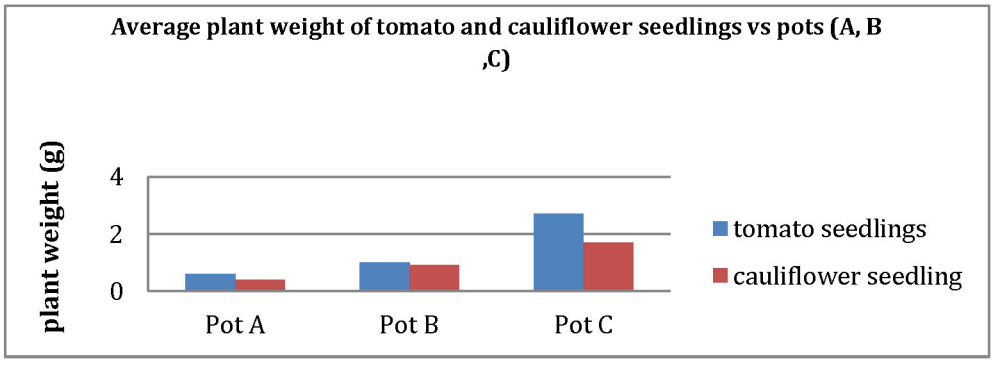


Figure 2. Graph showing average plant weight of tomato and cauliflower (3 weeks old) in relation with growing in the three types of pots.

Table 4. Results of plant height (cm), root length (cm) and plant weight of tomato and cauliflower seedlings grown in three different seedling pots (experiment 1).

Plant type	Pot type	Plant height (cm)	Root length (cm)	Plant weight (g)
Tomato	A	3.7^{a}	6.6^{a}	0.64^{a}
	B	5.5^{b}	8.3^{a}	1.05^{b}
	C	8.1^{ab}	13.9^{ab}	2.66^{ab}
	P-value	**0.005**	**0.005**	**0.005**
Cauliflower	A	3.5^{a}	6.9^{a}	0.39^{a}
	B	4.1^{b}	9.9^{b}	0.85^{b}
	C	3.7^{ab}	9.3^{b}	1.7^{ab}
	P-value	**0.001**	**0.026**	**0.001**
Lettuce	A	1.2^{a}		
	B	1.2^{a}		
	C	1.4^{a}		
	P-value	**0.6**		
Kailan	A	2.1^{a}		
	B	2.4^{a}		
	C	2.5^{a}		
	P-value	**0.7**		

Table 5. Results of plant height (cm), plant weight (g), leaf area (cm^2) and of total number plant leaves of kailan mature plants grown in the soil with the pots A or B and no pot (experiment 2).

Plant type	Planted with pot type in soil	Average plant height (cm)	Average number of total plant leaves	Average plant weight (g)	Average Leaf area (cm^2)
B. oleracea L. var. *albogabra*	A	16^{a}	10^{a}	56^{a}	134.8^{c}
	B	18^{b}	12^{a}	115^{a}	178.8^{b}
	C	25^{ab}	12^{a}	185^{a}	242.5^{ab}
	P-value	**0.007**	**0.47**	**0.07**	**0.042**

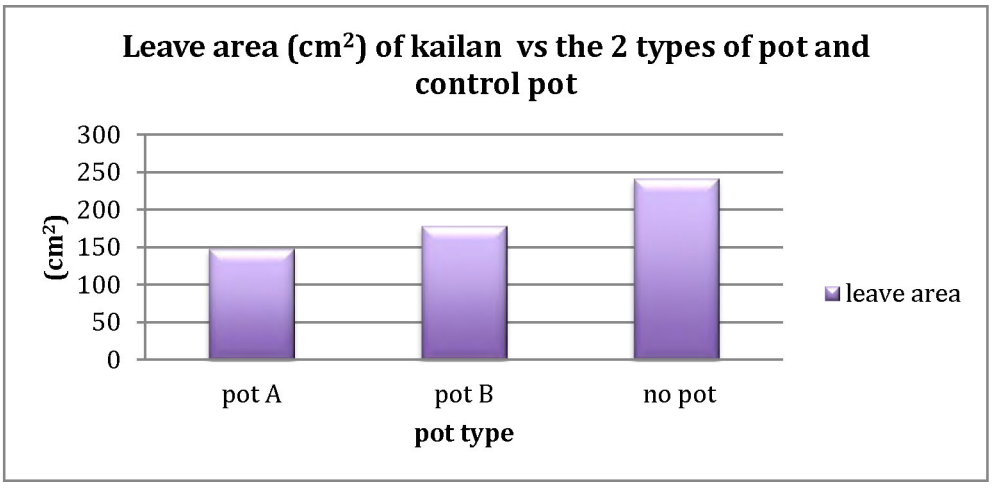


Figure 3. Graph showing relation between the leaf area of the mature kalian plants planted with organic pot and without pot in the soil (experiment 2).

Discussion

Experiment 1

The differences in plant height, root length, number of leaves and plant weight from tomato- and cauliflower seedling plants are a result of several uncontrolled factors like: volume of the various pot, water absorption capacity of the organic pot material (manure pot and paper pot had different water absorption capacity), the compaction (aeration) of the organic pot material and the interaction of the roots on the various pot materials. Most likely, the paper pots contained some ink residues and the fresh cow manure had a high acidity.

Experiment 2

The difference in plant height and leaf area of the kalian plants planted in a homogeneous plant medium with the organic pots and no pots could be explained as follows: disturbance in root penetration through organic pots, the water absorption capacity of the organic pot material, the moistness of the organic pots and the aeration of the pots material. The roots of the plants that were not planted with a pot in the soil could grow undisturbed. Roots could have absorbed water from the soil, but the roots of the plants in the organic pots could have been disturbed to absorb the irrigation water from the soil.

Conclusion

From the findings obtained from this study, the seedling plants that were planted in the plastic pots had better results than the plants in the newspaper organic pots, but the results of the plants grown in the manure pot with husk were good enough and this type of organic pot (pot B) could be used in future studies. The kalian plant planted with the pot B had good results, but the best harvested mature kalian plants were the ones without a pot.

Recommendation

In future experiments, several variations of the ratio of the materials that were used to make the pots be used in order, -to create a pot that is aerated, strong, with moderate water absorption and quickly decomposable. To make organic pots of cow manure the manure first need to be composted using high temperature (no weed seeds, odor and pathogens) and after that it can be used for pot production. To make uniform organic pots it is better to use a mold and a dryer. Organic pots can only be used for one time and not twice. The cost to produce organic pots on a household level can be divided in raw material purchasing (news papers, rice husk, cow manure) and labor. At these days newspapers, rice husk and cow manure are free of cost. So to produce organic pots the biggest cost depend on labor because organic pot production is very labor intensive.

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